

# PATENT SPECIFICATION



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## COMPLETE SPECIFICATION.

### Improvements relating to Phase Failure and Phase Reversal Protectors for Polyphase Electric Motors.

We, CHICAGO PNEUMATIC TOOL COMPANY, of Chicago Pneumatic Building, 6, East 44th Street, New York, United States of America (a company duly organized and incorporated under the laws of the State of New Jersey, United States of America), Assignees of CLARENCE JEWELL DRESSER, a citizen of the United States of America, of 1241, East 49th Street, Cleveland, Ohio, United States of America, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to electrical systems utilizing polyphase alternating current for the operation of induction motors, and more particularly to protective devices for preventing the disastrous effects which result from the condition known as "single phasing".

The recent adoption of high frequency polyphase current for operating portable electrical tools has brought the above noted condition into considerable prominence. The mere fact that the motor is used in a portable outfit with a flexible cable connection increases the occurrence of the condition from cable trouble. In addition the handling and operation of such tools by men unskilled in electrical matters sometimes results in improper connections. Such men often do not recognize the condition when it occurs and attempt to operate or to continue to operate the motor.

Among the objects of the invention are to protect motors of the type described from damage in the event of phase-failure or phase-reversal conditions, to break the electric connection so as to prevent starting of the motor or to stop the

motor in the event that such a condition develops, and to provide simple, compact, inexpensive and positive operating means for accomplishing the above objects. Other objects will be apparent from the detailed description which follows:

Accordingly, in a polyphase electrical circuit for operating one or more induction motors having means in the circuit for opening the same upon the flow of power therethrough for a short period, the power is shunted around the circuit opening means before the close of such period if and so long as the power characteristics of the circuit are normal.

The shunting may be effected by electro-magnetic means connected into the circuit.

The invention will now be described with reference to the accompanying drawings in which Figure 1 is a side elevation of one form of our invention.

Figure 2 is a detailed vertical sectional view on the line 2—2 of Figure 1.

Figure 3 is an end elevational view of the short circuiting switch as indicated by line 3—3 of Figure 1.

Figure 4 is an elevational view similar to Figure 3 showing the parts in a different position.

The invention comprises suitable means for interrupting or opening the circuit to the motor to be protected in the event of phase failure, or a phase reversal, and for maintaining the circuit interrupted until the trouble is remedied. It may consist of one or more sensitive circuit breaking devices which operate automatically and of means for preventing the operation of the short circuiting devices so long as the power characteristics of the circuit remain normal. One method of accomplishing this is by the use of short circuiting devices con-

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trolled by electro-magnetic means operating as a function of the condition of the circuit itself.

In the drawing the circuit breaking means is indicated in general at A, the short circuit means at B and the control means for the short circuiting apparatus at C. The control apparatus preferably takes the form of a small induction motor 5 having two or three phases, according to the current supply entering the same through leads *e*. Its windings are in series with the winding of the motor to be protected and are of low impedance. The rotor can be either wire wound or of the bar type and the whole is designed to give sufficient torque to actuate the short circuiting device B, which as is evident from Fig. 1, is mounted upon the movable armature shaft 7. Shaft 7 has a fixed arm 8 projecting therefrom which is arranged to limit the rotation of the shaft by coming in contact with a post or stop 9 projecting from the motor casing. A coil spring 10 secured to arm 8 at one end and to a post 11 on the motor casing at the other is arranged yieldingly to maintain shaft arm 8 in spaced relation with stop 9 as clearly indicated in Fig. 2.

The form of short circuiting switch disclosed comprises a cylinder 12 of insulating material fixedly secured upon shaft 7 and having imbedded therein a desired number of contact plates, in the present instance, two, 13 and 13<sup>a</sup>, which engage brushes of fixed contact members 14, 14<sup>a</sup> which may be secured to the base D upon which elements A, B and C are supported.

While any suitable or desired form of automatic circuit breaking apparatus may be used, that shown is of the ordinary fusible type comprising a desired number of separate fuses, in the present instance, two, 15 and 15<sup>a</sup>.

The fuses and control motor 5 are in series with the motor to be protected (not shown). Thus leads *f*, *g* and *h* extending to the tool motor connect respectively with a terminal of control motor 5, fuse 15 and fuse 15<sup>a</sup>. The opposite end of fuse 15 connects with another terminal of control motor 5 by a lead *g*<sup>1</sup> and the other end of fuse 15<sup>a</sup> with the third terminal of control motor 5 by a lead *h*<sup>1</sup>. Leads *g*<sup>2</sup> and *g*<sup>3</sup> connecting with opposite ends of fuse 15 extend respectively to fixed brush 14 and contact plate 13, respectively. Similar leads *h*<sup>2</sup> and *h*<sup>3</sup> extending from opposite ends of fuse 15<sup>a</sup> connect with fixed brush 14<sup>a</sup> and with contact plate 13<sup>a</sup>, respectively. Leads *g*<sup>2</sup> and *h*<sup>2</sup> have coiled portions to allow for the movement of the

portion of the short circuiting switch B to which they are connected.

The operation of the apparatus is as follows: When the circuit is closed either by throwing the line switch or by closing the switch on the portable tool, or other electrical device, current immediately flows through the windings of control motor 5 and through fuses 15 and 15<sup>a</sup> to the tool. At the same instant a torque is applied to motor shaft 7 by motor 5 in the direction of the arrow (Fig. 2) turning the shaft until arm 8 engages stop 9, the position of the parts being then indicated in dotted outline in Fig. 2. This partial rotation of the shaft 7 brings contact plates 13 and 13<sup>a</sup> into engagement with brushes or fixed contacts 14 and 14<sup>a</sup>, respectively (Fig. 4). Control motor 5 is so designed that the torque exerted is sufficient with a minimum current flowing to keep the short circuiting switch B closed against the pull of the spring 10, provided that all three phases are functioning. Should one phase become open the motor immediately loses its torque and spring 10 returns the motor to its normal position opening the short circuit switch B and throwing fuses 15 and 15<sup>a</sup> entirely into circuit. These fuses are very light having only capacity enough to carry the initial rush of current for an instant until control motor 5 functions to close the short circuiting switch and bridge the fuses. The result is that the fuses burn out making it impossible to operate the tool. By the same token if an attempt is made to start the tool when a phase is open or reversed, the control motor 5 will not function and the fuse will burn out as before.

From the above it will be apparent that the invention provides means for preventing operation of a polyphase motor when a condition of single-phasing or phase-reversal exists, that the apparatus provided for this purpose is positive in operation, simple, compact, cheap to manufacture and assemble, that having no heavy wearing parts or delicate mechanisms it is not likely to fail or get out of order, and that the only replacement parts are inexpensive fuses.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. A polyphase electrical circuit for operating one or more induction motors having means in the circuit for opening the same upon the flow of power there-through for a short period characterized in that the power is shunted around the

circuit opening means before the close of such period if and so long as the power characteristics of the circuit are normal.

- 5 2. A polyphase electrical circuit according to Claim 1 further characterized in that the shunting is effected by electro-magnetic means connected into the circuit.
- 10 3. A polyphase electrical circuit according to Claim 2 further characterized in that movable members effect the shunting of the power under control of said electro-magnetic means, the latter
- 15 actuating the movable members only when the power characteristics of the circuit are normal.
- 20 4. A polyphase electrical circuit according to Claim 2 and/or Claim 3 further characterized in that the electro-magnetic means is an induction motor having its windings in series with the motor or motors to be protected.
- 25 5. A phase failure and phase reversal protector for motors operated by poly-phase alternating circuit having sensitive circuit breaking means and an induction motor having its windings in series with the motor or motors to be protected
- 30 characterized in that the induction motor short circuits said circuit breaking means when the power characteristics of the circuit are normal.

6. A phase failure and phase reversal protector according to Claim 5 further characterized in that the induction motor has a rotatable shaft and the short circuiting apparatus is actuated by the movement of said shaft. 35

7. A phase failure and phase reversal protector according to Claim 6, further characterized in that a stop limits the rotative movement of the motor shaft at the position to make the short circuiting apparatus function. 40

8. A phase failure and phase reversal protector according to Claim 6 and/or Claim 7 further characterized in that resilient means are provided for restoring the motor shaft to normal position and for opposing the torque of the motor. 45

9. A phase failure and phase reversal protector according to any or all of Claims 5 to 8 further characterized in that the circuit breaking means comprises one or more light fuses. 50

10. A phase failure and phase reversal protector substantially as shown and described. 55

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[This Drawing is a reproduction of the Original on a reduced scale.]

